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Recording and light scattering on dynamic holographic gratings in $Sr_{0.61}Ba_{0.39}Nb_2O_6$: 0.002 wt.% CeO_2 crystal

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The crystals of strontium-barium niobate solid solutions $Sr_xBa_{1-x}Nb_2O_6$ (SBN:x) belong to highly efficient non-linear photorefractive media. These crystals can be considered as a promising material for recording of three-dimensional holographic grating, which is of the interest for practical applications such as optical memory.

We present the results of studying of the scattering properties of dynamic holographic gratings being demonstrated with lasers with different spectral output. The gratings were written in photorefractive SBN crystal sample by second harmonic of CW Nd:YAG laser (λ = 532 nm, $W_{out} \approx$ 200 mW, intensity ~3 W/cm^2, the beam divergence ~0.8 mrad) while using the loop scheme.

The parallelepiped shaped SBN:Ce sample (a×b×c = 8×6×8 mm^3) was used in experimental study. The element was prepared from the photorefractive crystal of $Sr_{0.61}Ba_{0.39}Nb_2O_6$:0.002 wt.% CeO_2 which was grown from the melt by modified Stepanov technique. The special die of capillary type was used to produce profiled crystal of high optical quality. The poling process was carried out by applying the DC electric field (E ~ 8 kV/cm) along c-axis of the crystal within 24 h at room temperature. As a probe light source the lasers CW Nd:YAG laser (λ = 1064 nm), CW He-Ne (λ = 632.8 nm) (with output power being up to 3 W and 50 mW, respectively) and pulse-periodic alexandrite laser (pulse energy ~50 mJ) were used. Experimental dependences of the reflection coefficient R of probe beams on variations of angle of incidence $\Delta\phi$ with respect to the Bragg angle (angular scattering spectrum) as well as spectral characteristics of incident and scattered radiation were investigated.

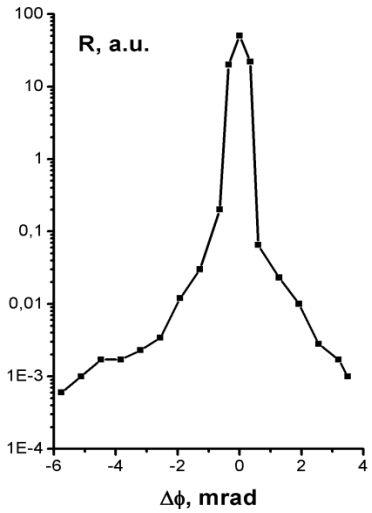

Figure 1. The angular spectrum of the scattering of Nd:YAG beam on holographic grating recorded in SBN:Ce crystal.

Maximum value of the reflection coefficient R_{max} ~ 50% was achieved for fundamental mode of He-Ne laser. The width of angular scattering spectrum $\Delta\phi$ was less than 1 mrad (FWHM) and well corresponded to the signal beam divergence of ~0.7 mrad. It is worth noting that R_{max} did not exceed 3% for multimode He-Ne laser with full divergence ~2.5 mrad.

In the case of alexandrite laser ($\lambda \approx$ 748 nm) with spectral width of 4.25 nm the spectral narrowing of the scattering light was observed depending on the signal beam divergence. Maximum value of the reflection coefficient R_{max} ~ 6% was achieved for laser beam divergence ~1 mrad with spectral width of the scattered light being 2.2 nm (FWHM). In this case wide wings, which are spectral characteristic of laser radiation, did not observe in the spectrum of scattered radiation. To increase the reflectivity efficiency of the gratings, the SBN sample was placed into an additional linear resonator. In this case, the power of scattered radiation was about 25% of the radiation power of the probe laser.

Experiments with using of CW TEM_{00} Nd:YAG laser (λ = 1064 nm) and beam divergence 0.75 mrad (FWHM) showed that maximum value of the single pass reflection coefficient was R_{max} = 5%. This value was not depended on the probe beam power in the range of 0.2-3 W. Thus, the Nd:YAG laser emission did not provide the erasing action on the holographic gratings.

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